The Pennsylvania Railroad in Wilmington, Delaware: Improvements Made Between 1902-1908
Along the old Pennsylvania RR right-of-way
Wilmington
New Castle County
Delaware

HAER DE-12

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

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HISTORIC AMERICAN ENGINEERING RECORD

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HAER DE 12A through 12F

Location: All sites are located along the old Pennsylvania Railroad right-of-way through Wilmington, Newcastle County, Delaware. Refer to Wilmington South Quad.

		UTM
12A	Repair Shops	18.455260.4399420
12C	Brick-Arch Viaduct	18.451620.4398300
12B	Swing Bridge	18.453960.4398780
12D	Station	18.452750.4398500
12E	Office Building	18.452720.4398030
12F	Power House	18.452820.4398380

Dates of construction: 1901-1908

Present Owners: Amtrak and Conrail

Significance: These improvements acted as a system to make Wilmington a central point along the New York to Washington rail corridor. In their appearance, construction and function, they typify the works of the Pennsylvania Railroad erected at the turn of the century.

Historian: Bruce E. Seely , 1976.

At the turn of the century, the Pennsylvania Railroad was one of the strongest and wealthiest companies in the country. This was a period of relative prosperity for all railroads, [1] and the Pennsylvania was one of the most prosperous. The company had extended its control to adjoining lines and had expanded its area of operation. One of the earliest acquisitions was the Philadelphia, Wilmington and Baltimore Railroad. In 1881, the Pennsylvania bought the railroad's stock for 14 million dollars, pushing the domain of the Pennsylvania southward through Delaware and Maryland. [2]

However, the railroad's greatest expansion came with the new century. Joseph Daughen and Peter Binzen commented, "At the turn of the century, American railroading reached its zenith. . . .It was in this period that the Pennsylvania, under A. J. Cassatt. . . made some of its most significant investments." [3] These purchases included the Long Island Railroad in 1900; 45 percent of the Chesapeake and Ohio Railroad; and portions of the Norfolk and Western, the Baltimore and Ohio and the Reading Railroads. Altogether, the company purchased 110 million dollars in stock.

The railroad's growth was not confined to stock purchases. The company also initiated major internal renovations. In 1902, the company began renovating the Main Line east of Pittsburgh. It four-tracked or double-tracked long stretches, built new yards, eliminated grade crossings and generally improved the right-of-way. This process took three years and cost 67 million dollars. [4] Tunnelling operations to give the Pennsylvania access to New York City started in 1904. While erecting Pennsylvania Station, the company drove 4 tunnels under the East River and 2 under the Hudson. [5] These facilities opened in 1910 and cost 100 million dollars. [6]

The Pennsylvania undertook these improvements because of increasing traffic over the company's lines. From 1897 to 1902, freight tonnage increased 64 percent while net earnings rose 78 percent to 25 million dollars. [7] The railroad required more trackage and could afford to make the necessary outlays. Importantly, this increase in traffic was not confined to the Main Line, [8] so the Pennsylvania chose to improve the route of the Philadelphia, Wilmington and Baltimore.

The first step in upgrading the P, W & B was to consolidate it with the Baltimore and Potomac Railroad. The merger produced the Philadelphia, Baltimore and Washington Railroad which now controlled the entire route to Washington. To improve this route, the new company began "the rebuilding of the line through the National Capital, the construction of a new passenger station in that city, the renewal of the bridge over the Potomac River and the elevation of. . .tracks through Wilmington and Chester." [9] This statement in an annual report formally announced a major construction project which lasted

for over 7 years. Although Wilmington received small notice in the announcement, that city's rail lines were due for large-scale alterations.

The formal announcement in the 1901 report was preceded by several months of speculation in local publications, especially the Wilmington Board of Trade Journal. The first story about possible railroad improvements appeared in that monthly publication in September 1900. Even then, it was evident that elevating the tracks would involve more than a simple trestle. The plans were not at all clear to the Trade Journal author, but the central point was that the railroad:

> . . .it is believed, contemplates the erection of a new station here. . . .When the station is erected it is thought that the main tracks through Wilmington will be elevated. . . . Plans for the new station and elevation of tracks through the city have been approved by the general officers of the company and developments along this line are awaited with interest. [10]

Further details of extensive new improvements emerged in a February 1901 article. By this time the company had announced its intentions. The elevation of the tracks through the city was only part of a larger scheme. The Edge Moor Cut-off around Wilmington [11] was to be double-tracked; the Claymont Curve north of the city was to be straightened. The company proposed to elevate its tracks and build a new station in Wilmington, and it would move its yards and shops to the northern part of the city. The first cost estimate was no less than 2 million dollars. [12]

In 1901 the company bought property along the right-of-way for the causeway through the city, [13] and it worked to gets its viaduct plans approved by municipal authorities. In August the railroad petitioned Wilmington's Street and Sewer Department for changes in the streets crossed by the viaduct, [14] and in December the city formally accepted the plan. [15] Although little construction work was undertaken in 1901, by the end of the year the way was cleared for major renovations in Wilmington.

The Wilmington Shops

Before much work could begin on the elevation of the right-of-way, provision had to be made for replacing the repair shops. The old shops dated as far back as 1854 and were located on the Christiana River waterfront, [16] off French and Water Streets. [Photos DE-12-18,19] The combination of a lack of room and the path of the elevated tracks forced the removal of these shops (and the freight yards, also located in the city) to a site known as Todd's Cut, some 2 miles north of the railroad's Brandywine River crossing.

Work began in the fall of 1902. The new sites for the freight yards and repair shops were low and marshy, requiring a great deal of gravel fill. Stone for the freight yard came from an excavation at Todd's Cut, using a "Mammoth" steam shovel which filled narrow-gauge railroad cars. As the cars dumped the stone, a large group of laborers leveled it, using shovels. A similar process was used at Shellpot Creek for the repair shops, [17] although the gravel was carried from a pit several miles south of the city. The average depth of fill at the site of the shops was 10 feet. [18]

The erection of the shops began in the summer of 1903 and the machinery was installed during the fall and winter of the same year. J. Milliken, superintendant of motive power, and C. G. Turner, master mechanic, drew up the preliminary plans. J. T. Richards, chief engineer (maintenance of way), supervised the design and construction.

A map in the Appendix shows the layout of the 27 buildings which comprised the shops. [19] Almost all the buildings could be entered from either end; this facilitated the movement of cars and engines. For fire protection, the buildings were separated, and the separation also allowed room for expansion. Most structures had temporary walls on one end, and there was room to double their length. Otherwise, the construction was very solid. All buildings, except the car erecting and painting shops, were of brick and steel construction. Except for steel in the roundhouse, which was provided by American Bridge, the Phoenix Iron Company supplied the structural steel for the shops.

The shops consisted of the following buildings:

a 44 stall roundhouse (30 were up by April, 1904);
coal trestle and sandhouse;
the main locomotive shop, with machine, erecting and boiler shops;
the blacksmith shop;
power house;
planing mill;
paint shop, with varnish room and tin shop;
car erecting shop, with upholstery and cabinet rooms;
storeroom and office;
lumber shed;
buffing building;
dry kiln;
dry lumber shed;
paint storage;
oilhouse;
lavatories;
roundhouse office;
yardmaster's office.

A structure important to all the shops was the one-story power house, 50 by 216 feet, divided down the center by a brick fire wall. It originally housed eight 250-horsepower Edgemoor water-tube boilers, hand-fired with coal. These boilers provided steam for three Hewes and Phillips cross-compound Corliss engines. Two engines powered 200 kilowatt Westinghouse two-phase 220 volt alternating current generators, while the third was directly connected to a 200 kilowatt direct current Westinghouse 250 volt generator. All engines were equipped with Dean jet condensers, although bypasses were provided. There were two 1000 horsepower Cochrane feed water heaters, and two Stilwell-Bierce & Smith-Vaile feed pumps.

The boiler room also housed four Ingersoll-Sergeant cross-compound steam and air compressors with a capacity of 513 cubic feet and a delivery pressure of 100 pounds. These compressors provided air to the interlocking signal system between Philadelphia and Wilmington. A water after-cooler and an atmospheric after-cooler prevented moisture from getting into the system and freezing in cold weather. Also, a 100 kilowatt Westinghouse motor-generator set and two 5-3/4 500 volt direct current generators powered by induction motors furnished electricity for signals between the same cities.

Other features of the power house included a hand-powered 10-ton overhead crane in the engine room and a narrow-gauge track under the boiler room floor for ash removal. Coal could be dumped directly into the boiler room from an outside trestle. The boiler's stack, 152 feet high, was 15 feet, 7 inches in diameter at the base, and 8 feet, 4 inches around at the top. The Alphonse Custodis Chimney Corporation of New York constructed it.

Electricity ran to the shops from main boards in the power house (9 for A.C. and 6 for D.C.) through lead-covered cables running in 3 inch bituminized fiber conduits buried in 3 inches of concrete. After the cables entered the various buildings, slow-burning weather-proof wire carried current to slate distribution panels. Westinghouse A.C. lamps provided exterior illumination; Nernst lamps provided interior lighting; and incandescent lamps were used for local lighting. [20]

The main locomotive building, with machine, erecting, and boiler shops, was a 180 by 500 foot structure, with the erecting shop in the center, and a 50 foot bay to either side for the boiler and machine shops. [Photos DE-12-1, 2, 3, 20, 21] A number of Shaw overhead cranes provided lifting capabilities. Two 65 ton cranes spanning 78 feet worked the erecting shop. Each was equipped with 2 auxiliary hoists for lifts near the post line. The machine shop and boiler shop each had one 15 ton crane of 49 foot span, and the boiler shop had another 20 ton crane. Abundant natural lighting came from monitors, windows and glass mounted in frames between the roof trusses. Unlike normal sawtooth roof structures, the skylights mounted on these frames sat on the sloped side, not on the vertical.

The erecting shop occupied the central bay and measured 80 by 410 feet. Three tracks with pits entered the building, although only one ran the whole length of the structure. The other 2 side tracks were cut short to allow room for heavy machine tools.

The machine shop occupied the south bay and was well equipped. [Photo DE-12-22] Some 100 tools were originally installed. Eighty-one were group driven by electric motors, and 19 others carried individual motors. For group-driven machines, line shafting was supported from the posts, hanging by a lattice structure. Many of the machines were new. Likewise, the boiler shop was well equipped [21] and had a track running the length of the bay for easy access.

The blacksmith shop was the other major building for locomotive repairs. [Photo DE-12-4] The structure was a high building, 80 by 269 feet. A single track ran through the center of the building, with various forges, furnaces, hammers and tools on either side. There were 20 small fires and 4 large furnaces on one side, and 7 large fires on the opposite side for frame repairs and heavy forgings. A large number of jib cranes were situated around these fires for moving work. The spring shop was located in the center of the building. As with all the buildings, the high windows provided abundant light and a clerestory monitor the necessary ventilation.

The roundhouse was a large one, 363 feet in diameter. [Photos DE-12-23, 24] The Railway Age noted that it was not typical of others on the Pennsylvania Railroad. The building sat on marshy ground atop 3152 wooden piles, driven in groups. These piles supported stone masonry arches which, in turn, supported the outside walls. [Photo DE-12-25] The use of arches led to a savings in material. The outside walls rose 30 feet; their high windows provided excellent lighting. Heat was provided by hot air driven through a brick conduit which discharged through tile pipes inside the engine pits.

Engines entered the building either over the 75 foot turntable, powered by a George P. Nichols & Brother of Chicago driving mechanism, or via a back door from the locomotive shop. [Photo DE-12-5] Inside, there were two drop pits and a number of small machine tools. These tools were group-driven by a 20 horsepower induction motor.

Closely connected with roundhouse operations were the coal wharf, sand bin, ash pits and inspection pits. [22] Located about 200 feet south of the roundhouse, the wharf was a heavy yellow pine trestle some 633 feet long, erected on stone-capped wooden piles. The wharf was designed to hold 1120 tons of coal in bins fed from two symmetrical tracks. Adjoining the roundhouse was the two-story brick roundhouse office and bunkhouse, 27 by 75 feet. This whole roundhouse grouping was somewhat removed from the rest of the complex, but very convenient to both the main line and the Edgemoor freight yard.

The Wilmington Shops also contained facilities for passenger coach building and repair. The two main structures were the paint shop [Photo DE-12-27, 27] and the car erecting shop, each 180 by 300 feet and of identical construction--the only buildings with timber framing. [Photos DE-12-6, 7] The roof contained large skylights for excellent natural lighting. Both buildings were heated from overhead galvanized ductwork and blowers. These two structures were 250 feet apart and connected by a transfer table 70 feet long and 390 feet wide. This table moved in a pit in order to connect the rows of parallel tracks which entered the car shops.

Each building was divided into several rooms. The car erecting shop consisted of the main repair and erecting floor, 200 by 180 feet, a cabinet shop and an upholstery shop. The main floor could accomodate 36 coaches. The cabinet shop was well equipped with woodworking tools, [23] and all were group-driven except for a scroll saw, a rip saw and a moulding machine. One track ran from the transfer table through both this room and the upholstery shop, while another entered only the cabinet shop. There were 15 work benches in the shop, and storage space for 4 engine cabs or 8 pilots. The upholstery shop had storage for seats, a cutting table, benches and picking and cleaning rooms.

Across the transfer table was the paint shop. The main painting room measured 180 by 220 feet; the varnish room and pipe and tin shop divided the remaining space. The main room housed 11 tracks from the transfer table and had a capacity of 28 coaches. In this room, adjustable cast iron brackets were mounted for easy scaffold erection by the painters. A paint storage house, 50 by 52 feet, having brick walls and concrete joists and beams, was just north of the paint shop.

As coaches built at this time were wooden, the planing mill was essential to the work of the car shop. The mill building was 70 by 200 feet, with two tracks running the length of the floor. Most of the machinery was driven by individual motors. [24] This was the first building to be opened and provided lumber for both car repairs here and freight car repairs in the adjacent Edgemoor yards.

Other buildings associated with woodworking were the lumber shed, a dry lumber shed and a dry kiln. The kiln was 29 by 32 feet, of brick with copper edgings. Steam for drying was piped from the boilers into heaters, then through condensers before a blower forced it into the kiln.

The other structure involved in car repairs was the buffing building. Adjacent to the car erecting shop, this 91 by 40 foot building housed all of the brass finishing equipment. This brick and terracotta building had 16 windows for natural lighting and 12 Globe ventilators. The structure was partitioned into 6 rooms, one each for repairing, receiving, plating, laquering, buffing and delivering the brass work. There were 6 buffing machines, and

each was exhausted mechanically through an underground conduit.

The remaining structures included lavatories, an oil and waste storage house, a one-story yardmaster's office, and a 2-story storeroom and general office building.

The railroad contracted with a number of firms for the re-erection of its shops. Ryan & Kelley erected the locomotive shop; Armstrong and Latta built the roundhouse, roundhouse office, planing mill, power house, blacksmith shop, lumber shed and coal storage facility; A. W. Ferguson contracted for the car and paint shop; W. R. Dougherty for the office and storeroom; A. S. Reed & Brothers Company for the oil and waste storage, paint storage, buffing building, dry kiln, and two lavatories. William Bayley & Sons of Milwaukee supplied the heating and ventilation systems, with fans and engines, for the car and paint shops, locomotive shop, mill and roundhouse. Finally, the Benjamin F. Shaw Company of Wilmington installed the steam fittings and piping.

Obviously, the buildings represented a major expenditure for the railroad. Based upon the cost per square foot given in The Railway Age and the size of the buildings, the following is a listing of the cost for the 8 major buildings.

Blacksmith Shop	$2.25/sq. foot	$ 48,420
Locomotive Shop	2.20/sq. foot	201,960
Car Shop	1.20/sq. foot	64,800
Paint Shop	1.20/sq. foot	64,800
Office and Storehouse	1.20/sq. foot	12,000
Planing Mill	1.85/sq. foot	25,900
Power House	3.50/sq. foot	37,800
Roundhouse	$4,150/stall	125,000
	Total:	$580,680

These figures do not include the costs of equipment and machinery.

These shops rapidly became a major repair center for the whole East Coast corridor of the Pennsylvania Railroad. Originally designed to repair 35 locomotives and 75 coaches each month, [25] this capability soon fell short of the railroad's needs. In 1929, 89,000 square feet of space were added to the car erecting and paint shops; this space housed the electrical department, passenger car truck shop, passenger car paint shop, and paint storehouse. A network of concrete truckways was contructed to connect the buildings. By that time, all classes of repairs on suburban electric cars and all miscellaneous electric repairs for the Eastern Region were handled here. Likewise, air brake, pneumatic tool, and acetylene repairs came to Wilmington. As of 1 June 1929, the Wilmington shops employed 1600 men. [26]

Additional alterations took place two years later. The two 65 ton overhead cranes in the locomotive shop were replaced with

100 ton cranes. The varnish and upholstery rooms and the tin shop were relocated, and permanent scaffolding was installed in the car erecting shop. In the machine shop, creosoted wood blocks set on a concrete base replaced the old plank flooring. A new battery repair shop for car-lighting batteries was built. The power distribution system had to be enlarged to handle the motorization of certain machine tools, and one 10-K V.A. 2300-3300 volt transformer was installed for sectionalizing power lines. Modern flood lighting was installed as well. [27]

As witnessed by some of the above alterations, more and more electrical repairs were being performed in Wilmington. This trend led Wilmington to become, "the maintenance base for the Pennsylvania's electric locomotive fleet." [28] In 1928, the railroad completed its first section of main-line electrification with a single phase catenary stretching from Philadelphia to Wilmington. [29] Shortly thereafter, Wilmington started performing suburban car repairs. But it was with the plans for the electrification of the New Yrok to Washington corridor that electrics really moved into Wilmington. In 1933, a test track was built at Claymont, just north of the shops, to help correct a tracking problem on the P 5a locomotive. Later the comparison tests which led to the GG 1 locomotive were conducted here. [30] When the corridor opened on 28 January 1935, Wilmington was the main repair and maintenance headquarters for all electric locomotives.

While the shops had gained all the electrical repairs, they had lost the car building operations because of the shift from wood to steel cars. [31] Repairs of multiple-unit commuter cars replaced car building. The planing mill machinery was torn out, and the building became the air brake shop, probably in 1929.

In the 1940s, diesels were added to the locomotive roster at Wilmington, but the change from steam to diesel locomotion did not cause a major upheaval here. Electric locomotive heavy repairs remained the primary function of the shops, a function which remained unchanged even in 1976. Ownership of the facility passed to Amtrak on 24 February 1976, and it is the only major maintenance shop for Amtrak's electric locomotives. All heavy repairs take place here and all wheel work. All Metroliners are based at Wilmington, as are 243 other electric locomotives, including 106 of the venerable GG 1s, and 52 diesels. Each receives periodic maintenance, as well as heavy and running repairs, wreck repairs, and the federally-mandated monthly inspections. Employment is down to 734 men, but the shops remain a center of bustling activity and a vital part of Amtrak. The buildings, however, show their age. Most of the windows are gone, replaced by transluscent green fiberglass panels. Many of the buildings are no longer standing, like the dry kiln, lumber shed, lavatories, paint store house, the roundhouse office. The old planing mill stands empty, and only half of the powerhouse remains. All the electrical equipment is gone, and only modern steam generators are housed inside the engineroom. Only one small section of the roundhouse remains, and it is ready to collapse. All of the steam-related

facilities have been torn down, except for a later concrete coal tipple.

The end of steam power required certain alterations in the plan and function of the buildings. The blacksmith shop now houses the wheel shop and air compressor repairs. The machine shop has been altered several times, with the changes in motive power and the addition of war surplus tools at the end of the Second World War. As mentioned above, the car shops are completely changed around. They now house the facilities for Metroliner and suburban car repairs and inspections. On the whole, though, the shops remain as vital a part of the railroad's operation as when they were built.

Viaduct

While the shops were being built at Todd's Cut, work began on the elevation for the right-of-way through Wilmington. [Photos DE-12-28, 29, 30] The Pennsylvania Railroad's engineering department in Philadelphia, under chief engineer William H. Brown, turned out all the plans for this viaduct. For those who know any of the other works of Brown, the appearance of the causeway should come as no surprise. It was during Brown's tenure that in 1887 the Pennsylvania embarked upon a major building program using stone-masonry. David Plowden, author of Bridges, has commented that this use of stone represented a revival of that material, for which the railroads were responsible. Plowden noted:

> The Eastern trunk lines, particularly the Pennsylvania and New York Central, whose empires were established, preferred to pay more for a stone bridge than to risk experimenting with the new metal steel. . . .With money to spend, the massive stonework structures they now produced were among the safest, strongest yet. . . .Furthermore, it was more than likely that their directors, moguls like Morgan and Vanderbilt, wishing to bestow a degree of monumentality to their empires, felt that stone bridges were best suited to glorify their achievements. [32]

The Pennsylvania Railroad launched the most ambitious program of stone construction. By the time it was completed, "the line had put up some of the largest stone bridges ever built." [33] The Company built large stone arch bridges at Trenton and New Brunswick, New Jersey, and at Coatesville and Shock's Mill Pennsylvania. In 1902, it opened the largest stone arch railway bridge in the world, the Rockville Bridge across the Susquehanna River near Harrisburg. [34] The Pennsylvania's decision to use stone on the Wilmington viaduct places the elevated in the mainstream of the engineering work the railroad carried out from 1887 to 1910.

The primary motivation for elevating the tracks through Wilmington also was typical of the railroad's engineering efforts.

For one thing, the viaduct offered a straighter alignment, a constant goal of any railroad. But more importantly, the elevated eliminated a number of grade crossings. This was a system-wide crusade for the Pennsylvania, designed to reduce accidents at the crossings. The Fifty-eight Annual Report, 1904, noted, "Large expenditures were. . .necessary upon the Philadelphia, Baltimore and Washington. . .in the elimination of grade crossings through cities. . . ." [35] Besides elevating the tracks through Wilmington, the company was constructing viaducts through Pittsburgh, Philadelphia, New Brunswick, Newark, and Rahway, New Jersey, and New York City. [36]

As mentioned, the railroad submitted its proposals to the city in August 1901. These plans called for the new structure to follow the approximate path of the old right-of-way, with minor straightening. Initially, the railroad intended to erect an iron structure resembling bridgework over the stretches where the old and new tracks met, to prevent any disruption of service to manufacturing establishments in the city. Elsewhere, the plan called for an earth fill between stone walls, 12 to 14 feet high, to carry two tracks. Streets were to be crossed by iron bridges, requiring few alterations to city roads. [37] Overall, the viaduct was almost 4 miles long.

There were a few alterations in the plans. The bridgework was never built since work proceeded without interrupting traffic. The retaining walls were not suitable for the whole length, as will be discussed below. But on the whole, the original plan was followed.

In the spring of 1902, the first construction work on the viaduct began downtown, from Market to King Streets. Work moved to Market and Shipley and on southward toward the old freight yards, then back to French Street and north toward the Brandywine. [38] During the same time, work began at Shellpot Creek to the new shop site and moved south toward the river.

This entire section of the viaduct, from the shops south to Liberty Street, consisted of 2 retaining walls of ordinary building stone, with an earth fill. Four feet of ballast on top carried the tracks. Ryan & Kelley, the contractors, [39] built the walls on concrete foundations, [40] and the earth excavated for the foundations was used as the fill. [41] At street intersections, the retaining walls were squared off to form abutments for plate girder bridges. [Photo DE-12-8] Apart from street crossings, there were only two other breaks in the retaining walls. One of these was from about Lombard Street to Church, where the eastern side retaining wall was not built and the elevated is simply an earthen embankment. The other break in the retaining wall was at the Brandywine. Here the old bridge was replaced by a new swing bridge, [42] in order to raise the crossing to the level of the viaduct. [Photos DE-12-9, 10, 11]

Work began at the bridge with the sinking of a caisson for the pivot pier in the winter of 1903, but a freshet swept it away. Replaced, it was successfully positioned and Wakefield triple sheet piling was driven around the outside. The pier was 35 feet, 4 inches in diameter, constructed of concrete with a coursed stone facing; the pivot itself was seated upon a granite block. Ice-breakers were built at either end to protect the pier from both river and tidal action. The two abutments and the second pier were built of rockfaced ashlar set in cement. As on the pivot pier, granite was used for the bridge seats.

The bridge itself is of two sections, fabricated by the Phoenix Bridge Company. The first section, from the south bank of the Brandywine, is a 78 foot plate girder bridge, running to the first pier. The second part is the swing bridge, a 158 foot fish-belly girder, which provided two 59 foot-wide openings. The girders were 6 feet 3-1/2 inches deep at the shore ends and 10 feet 6 inches at the center pier. A girder runs under each rail of the three tracks. A 30 horsepower gasoline engine opened the bridge. The revolving base is formed by 24 inch diameter wheels rolling on a 16 foot 3 inch radius track.

Since the Corps of Engineers in 1903 considered the Brandywine a navigable stream, the railroad had to build a drawbridge. Thus a watchman ran the bridge and was provided with a shelter at track level to house the signal levers which controlled traffic at the bridge. A larger building housed the engine. [43] In 1976, neither of these frame structures existed, and the bridge seemed to be permanently closed. The bridge was still in good repair on the electrified high speed line from New York to Washington.

At about Liberty Street, as the viaduct swings out of Wilmington, the retaining wall changes to a series of brick arches to carry the tracks to the end of the elevated. [44] Originally, the same retaining wall and earth fill construction was called for. But borings indicated that under the old roadbed--6 to 8 feet of fill--there existed a layer of soft mud from 15 to 25 feet deep. This discovery eliminated the possibility of constructing retaining walls while keeping traffic moving at the same time. So a revised plan called for an arched viaduct to span this soft ground. [Photos DE-12-12, 13, 31]

These brick arches each had a span of 41 feet and a rise of 8 feet, on a radius of 30,26 feet. The piers consisted of a concrete footing on 8 feet deep and 10 feet wide of hard gravel, although on occasion rock was reached below the mud. Above this base, 8-foot wide rubble masonry constructions were built to the level of the foundation offset. From the foundation offset, the piers were built of quarry faced sandstone, 6 feet wide and 4-1/2 feet high, to the skewback. The arches themselves were built of brick, although stone had been called for originally. This switch was made because of a lack of readily-available stone. The arch rings were built of

34 to 35 inches of brick. Rubble was used for the backing and the whole was covered by 1 inch of asphalt, which connects to the weepers above each pier. [Photo DE-12-32] Two string courses of sandstone top the arches. The lower is 16 inches deep and 36 inches wide, with a 6 inch overhang. The upper course is 18 inches deep and 27 inches wide. The extreme width of the viaduct is 42 feet. To level the roadbed, waste material was used as fill and broken stone ballast was added on top to support the tracks.

The only exceptions to this arrangement came at the northern end of the arches, as the line turns to enter Wilmington. Here the piers were built in a wedge shape, 15 inches wider on the outside than on the inside of the curve, to eliminate the need to skew the arches. Another type of arch was built on this same curve, although it is within the retaining wall. Near Justison Street, an open drain or sewer crossed under the line, so a ribbed brick arch was constructed. Altogether, 12 ribs were used to construct this 35 foot skewed arch. In this and all of the wall construction, stiff leg derricks and steam powered hoists were the primary lifting devices, as shown by photographs in The Railway Age. [Photos DE-12-33, 34]

One interesting construction note is the manner in which the arches were waterproofed. [45] The tops of the arches were first smoothed with a cement mortar. Then a layer of 1/16th inch Hydrex felt was laid down onto a coating of asphalt cement. [Photo DE-12-35] Five layers of each were applied. The ends of the felt were cemented to the underside of the coping and protected by one course of brick laid in Portland cement mortar, or equal parts sand and cement. The rest of the surface was coated with just the mortar. Tests found this procedure resulted in perfect water tightness. No water percolated through the arch ring. Instead, it ran off the arch and was carried outside the structure through drain pipes.

The arches ran for about a mile from the curve at Liberty Street to the point where the B & O and Reading tracks cross under the viaduct on plate girder bridges. They were broken only at Beech Street by another plate girder bridges. Except for the heavy stone rangework acting as bridge abutments, the whole was of brick construction.

The viaduct was the largest part of the improvements through Wilmington and took the longest time to build. In October, 1903, there were 1200 people working on the elevated alone and the weekly payroll was $21,000. Originally, plans called for the completion of the work by mid-1905, [46] and for the most part it was. But some shortcuts were taken to get it completed, such as on the retaining wall north of the Brandywine. There, after the first wall was ready, a heavy trestlework and planking was erected so that the thousands of carloads of fill could be dumped in even though the second wall was not built. [47] By March 1906, the elevation was still not finished; [48] it was not until 1908 that

the work on the viaduct was complete. [49]

Passenger Station

Intimately connected with the newly elevated tracks through Wilmington was the construction of a new passenger depot. The P, W & B had built a passenger station in the 1870s on almost the exact site of the present one [Photo DE-12-36] but due to the realignment of the tracks and their elevation, a new depot was required. From the very first announcement, the new station attracted more attention than the other improvements. In February 1901 the Board of Trade Journal wrote:

> . . .the officers of the company in this city feel sure that the station will be one of the largest buildings in the city and will be made large enough to meet all needs of the railroad for years to come. It will have the effect of giving Wilmington a metropolitan appearance. The station will be made large and imposing because Wilmington is the headquarters of the road. [50]

Work on the station was delayed until the construction of the elevated tracks forced the removal of the old depot. It was not until July and August of 1905 that the old building was demolished. Demolition was quick and total; cables attached to locomotives were wrapped around the walls and the building was pulled apart. A temporary frame structure building replaced it. [51]

The construction of the new station began almost immediately, from plans drawn up by Furness, Evans & Company of Philadelphia. [52] These plans called for a steel framed building with brick walls and stone and terracotta trimmings. [53] [Photos DE-12-14, 15, 37]

The station situated at the corner of Front and French Streets measured 167 feet wide and 193 feet long. The first floor housed the baggage rooms, express agent, ticket office, restaurant, and other passenger services. The second floor included the waiting rooms and platforms. Four tracks ran almost exactly down the middle of the second floor. There were three platforms, [DE-12-16] the 4 tracks being split into pairs by a center island platform. The platform serving the southbound tracks was 900 feet long; the island was 800 feet long; and the northbound platform was 700 feet in length. Stairways and three baggage lifts connected the two floors and skylights dotted the platforms to light the first floor.

The fact that the trains ran right over the building was one of two major obstacles the architects faced. The other adversity lay in the fact that an ancient riverbed ran directly under the building. To overcome this difficulty, the architects supported the building on 2 parallel rows of brick arches, which rested in turn upon a grillage system of piling. The piers to support the arches were poured of concrete mixed from Atlas Portland or Giant cement, sand and granite.

Regarding the station's construction, The Railway Age commented, "In the details of construction the utmost care has been exercised in selecting the most perfect material for the purpose." Kittaning brick was used in many walls, and the exposed arches of the platform The brick and terracotta were all laid in La Farge cement, and all interior terracotta was painted with this cement tinted with marble dust. The ground floors were cement resting on 18 inches of cinders, while hollow terracotta tile arched floors were used elsewhere. The bathroom floors were marble, covered with 1 foot by one foot marble tiles. All public rooms were finished in quartered white oak.

Girders carried the roadbed through the station; between the iron work a layer of mastic Neufchatel asphalt carried the ballast. Asphalt also underlaid the platforms, sidewalks and floors, and it in turn was covered with 4 inches of Granolithis finish.

The roofing was tile shingles 6 by 12 by 1/2 inches, showing 5 inches to the weather, laid on 2-ply extra heavy roofing felt. Copper nails secured the tiles and all roofing fixtures were 16 ounce copper; the eave pipes were 20 ounce copper. The platform roofs were slag and tar over 4-ply roofing felt.

The final feature was the clock in a three-story tower on the corner of Front and French. The brick tower is square and there is a clock face on all four sides.

The station was to be completed by the end of 1906, and by March all of the structural material was in place. [54] But the Philadelphia, Baltimore and Washington Sixth Annual Report for 1908 noted that it was only in that year that the final expenditure was made. [55]

In 1976, the station came under the direct control of Amtrak, which instituted some minor maintenance. The first floor plan has been altered over the years, but on the whole, the building is relatively unchanged and in good condition in its seventieth year of use.

Office Building

Just before the railroad began to build the new station, construction started next door on French Street on a five-story office building. [56] [Photos DE-12-17, 38] The intention of the company was to consolidate the offices of the railroad into one structure. Furness, Evans & Company designed this building, just as they had the station. This fact is obvious when one compares the two structures, as the materials are identical and the designs mesh. As if to reinforce this architectural link, a covered bridgeway connects the two buildings at the second floor level.

The Railway Age accurately summed up the office's appearance: "This building, although making no pretensions to architectural adornment,

is of very dignified proportions, 180 feet long by 52 feet wide over all . . . ." [57] The building, like the station, was steel frame with brick walls and red terracotta trim at the doors and windows.

By November, 1905, the exterior of the building was completed and occupancy soon followed. Unfortunately, the building has not survived as well as the station, and in 1976 it stood empty.

Other Additions

Along with the major improvements and additions to the line during this time, the Pennsylvania also added several smaller structures during its building boom. First in importance was the power house to supply heat and electricity to the new station and office building. Constructed at Water and Walnut Streets, the building was 35 by 50 feet and sported a 120-foot stack to carry the exhaust gasses over the office building. Construction could not have began until 1906. [58] Like all the other buildings, this one was steel framed with brick walls. Insurance maps show that three boilers provided steam. [59] As late as 1936, the building still had its stack, [60] but sometime shortly thereafter the building appeared minus the stack and was labelled as storage. [61] In 1976, the building was part of a wholesale warehouse firm and in only fair condition.

Other improvements included a new freight facility at Third and Pine Streets, 40 feet wide and 272 feet long. Intended to handle outgoing freight, it also housed the offices for the clerks and officers. An existing facility at Fourth and Pine, which still is in use today as a shop for running repairs to Amtrak cars, was converted then to handle only the incoming freight. [62]

The construction of the new freight house forced the relocation of the freight yard to Fifth and Church Streets and to the old car shop site. It held 60 cars. Today, this outgoing freight house does not exist. [63]

Finally, mention should be made again of the Edgemoor freight classification yard adjacent to the new shops, and the installation of the compressed air signal system between Philadelphia and Wilmington, which eliminated many small signal towers. This system was an intricate part of the expansion of that entire line to four tracks. The compressors were located at Wilmington and at Thurlow. [64]

By 1908, the Pennsylvania Railroad (acting through its subsidiary, the Philadelphia, Baltimore and Washington Railroad) had completed its improvements in Wilmington. The work took seven years and was costly. But for the years 1906, 1907 and 1908 (the only years for which figures could be located) the P., B., and W. spent the following sums on the improvements. [65]

	1906	1907	1908
Elevated and Justison Street Yard	$588,344.16	378,846.22	6,957.63
Wilmington Passenger Station	203,681.35	108,851.68	64,481.00
Wilmington Power House	19,933.39	17,335.91	---
Third Street Car Yard	---	27,289.96	868.35
Total All Construction [66]	3,678,876.17	2,977,017.76	1,032,448.85
Total Real Estate	794,450.28	---	---

On top of these expenditures should be added the shops, which cost $580,000 just for the buildings. Also, the office building cost $80,000 and does not show in the figures. [67]

From the sketchy data available, it is impossible to determine the total cost of the improvements in Wilmington. Altogether, though, the P. B. & W. spent some 10 million dollars during this period, including improvements elsewnere on the line. This figure derives from loans the Pennsylvania made to the P.B. & W. $3,313,826.25 in 1906 and $6,081,504.80 in 1907. [68]

But the significance of these improvements lies not in their size, complexity or expense, for larger and more magnificent structures of each type can be found elsewhere. Rather, the importance of these structures lies in the way they fit together as a system. With them, Wilmington became a major center of activity on the New York to Washington line, able to manage every facet of railroad operation.

NOTES

[1] John F. Stover, American Railroads (Chicago, 1961), pp. 176-6.

[2] Anna T. Lincoln, Wilmington, Delaware: Three Centuries Under Four Flags, 1609-1937 (Rutland, Vermont, 1937), p. 282.

[3] Joseph R. Daughen and Peter Binzen, The Wreck of the Penn Central (Boston, 1971), p. 43.

[4] H. W. Schotter, The Growth and Development of the Pennsylvania Railroad Company (Philadelphia, 1927), p. 281; and Pennsylvania Railroad Company Fifty-sixth Annual Report, 1902, pp. 23-25.

[5] "A Century of Progress," The Mutual Magazine, Pennsylvania Railroad Centennial Souvenir Edition, Volume 31, no. 10, April 1946, p. 15.

[6] Stover, American Railroads, p. 176.

[7] Pennyslvania Railroad Company, Fifty-sixth Annual Report, 1902, p. 24. Hereafter, the Pennsylvania's reports will be cited as P.R.R. and the year of the report.

[8] "The same conditions which necessitated liberal expenditure on your Main Line, also, as heretofore noted, compelled the lines west of Pittsburgh to make large outlays; and this was equally the case with the Northern Central, Philadelphia Baltimore and Washington, and Long Island Railroad Companies." P.R.R., 1903, (57th), p. 21.

[9] Philadelphia, Wilmington and Baltimore Railroad Company, Sixty-fourth Annual Report, 1901, pp. 8-9.

[10] "New Pennsylvania Station?" Wilmington Board of Trade Journal, II, no. 6, September 1900, p. 10. Hereafter cited as the WBTJ.

[11] For the location of this and all of the sites included in the Pennsylvania's improvements, see the map in Appendix I.

[12] "Railroad Betterments," WBTJ, II., no. 11, February 1901, pp. 1-2.

[13] WBTJ, II., no. 12, March 1901, p. 11; and WBTJ, III., no. 3, June 1901, p. 11.

[14] "Elevated Tracks," WBTJ, III., no. 5, August 1901, p. 13.

[15] "Wilmington to Have 'L' and Car Shops," WBTJ, III., no. 9, December 1901, p. 14.

[16] "The Wilmington Shops of the Pennsylvania," The Railway Age (Chicago), 34, April 1904, p. 752. Hereafter cited as "The Wilmington Shops". Please see the photographs in the Appendix.

[17] "Digging Away Big Hill," WBTJ, IV, no. 7, October 1902, p. 13.

[18] "The Wilmington Shops," p. 752. All further information is drawn from this article, pp. 752-762; and "Mammoth Railroad Shops," WBTJ, V., nos. 4 and 5, pp. 1-3.

[19] See Appendix II This map is traced from "The Wilmington Shops," p. 752. See also Atlas of Wilmington, Franklin Survey Company (Philadelphia, 1936), plate 10.

[20] "The Wilmington Shops," included a supplement which provided detailed floor plans and sections of the power house.

[21] See Appendix I for tool listing.

[22] "The Wilmington Shops," p. 763 shows a plan and section of the inspection pits.

[23] See Appendix I for tool listing.

[24] Ibid.

[25] "The Wilmington Shops," p. 752.

[26] "Pennsylvania Railroad, Wilmington Shops," Wilmington, 4 July 1929, p. 18.

[27] "Pennsylania Railroad," Wilmington, 6 July 1931, p. 77.

[28] William D. Middleton, When the Steam Railroads Electrified (Milwaukee, 1974). p. 355.

[29] Ibid., p. 317.

[30] Ibid., p. 323.

[31] All additional information on the shop came from a visit to the shops and a discussion with R. F. McCurdy, superintendant of locomotive maintenance. Appendix II includes a copy of a thumbnail sketch of the history and current duties of the Wilmington Shops.

[32] David Plowden, Bridges, the Spans of North America (New York, 1974) pp. 30-31.

[33] Ibid., p. 31.

[34] Ibid., p. 32. These were massive bridges. The bridge at Trenton had 18 spans; Coatesville and New Brunswick 21 spans; Shacks Mill, 28 spans; Rockville, more than 40 spans.

[35] P. R. R. , 1904, (58th), p. 21.

[36] P. R. R., 1902 (56th), p. 25.

[37] "The Claymont Curve," WBTJ, III, no. 5, August 1901, p. 13.

[38] "Work on the Elevated Road," WBTJ, III, no. 12, March 1902, p. 14.

[39] Ibid.

[40] "Railroad Improvements," WBTJ, IV., no. 5, August 1902, p. 5.

[41] "Work on Elevated Road," WBTJ, III., no. 12, March 1902, p. 14.

[42] Plans and sections of the bridge and caisson can be found in "Pennsylvania Improvements in Wilmington," The Railway Age, 39, 31 March 1905, p. 534. All of the following information is from that article, pp. 533-535.

[43] The bridge was completed by 1905.

[44] The following information is drawn from "Philadelphia Improvements in Wilmington," The Railway Age, 39, 31 March 1905, pp. 532-533. Plans and sections of the arches can be found on p. 535. Photographs show the arches.

[45] "Pennsylvania Improvements in Wilmington," The Railway Age, 40, 3 November 1905, p. 563; and "Waterproofing Brick Arches," The Engineering Record, 52, no. 22, 25 November 1905, p. 603. See photograph.

[46] "Work on Retaining Wall," WBTJ, V., no. 7, October 1903, p. 13.

[47] "Work on Railroad," WBTJ, VI., no. 3, June 1904, p. 12.

[48] "Work on the Station," WBTJ, VII., no. 12, March 1906, p. 12.

[49] Philadelphia, Baltimore and Washington Railroad Company, Sixth Annual Report, 1908, p. 18. Hereafter cited as P. B. & W. R. R. and year of report.

[50] "Railroad Betterments," WBTJ, II., no. 2, February 1901, pp. 1-2.

[51] "Like Swarm of Bees," WBTJ, VII., no. 4, July 1905, p. 3; and WBTJ, VII., no. 5, August 1905, p. 7.

[52] Except where otherwise noted, the information on the station is drawn from "Pennsylvania Improvements in Wilmington," The Rail-Way Age, (Chicago), 40, 3 November 1905., pp. 565-6. Pages 563 and 565 show floor plans of the building.

[53] "Work on the Station," WBTJ, VII., no. 12, March 1906, p. 12.

[54] Ibid.

[55] P. B. & W. R. R., 1908 (6th), p. 18.

[56] The information on the office building is drawn from "Pennsylvania Improvements in Wilmington," The Railway Age (Chicago), 40, 3 November 1905, pp. 563-565. See photographs.

[57] Ibid.

[58] "To Build Power House," WBTJ, VII., no. 9, December 1905, p. 11; and "New Powerhouse," WBTJ, VII., no. 12, March 1906, p. 11.

[59] Sanborn Map Company, Insurance Maps of Wilmington, Delaware (New York, 1927, with revisions), I., plate 29.

[60] Franklin Survey Company, Atlas of Wilmington (Philadelphia, 1936) plate 3.

[61] Sanborn Map Company, plate 29.

[62] "New Freight House," WBTJ, VI., nos. 5 and 6, August and September 1904, p. 12.

[63] Ibid.

[64] "Automatic Signal System," WBTJ, V., nos. 4 and 5, July and August 1903, p. 7.

[65] Figures are drawn from the P. B. & W. R. R. 1906, (4th), pp. 16-17; 1907 (5th), pp. 17-18; 1908 (6th), p. 18.

[66] This entry represents all of the construction on the P. B. & W. R. R., not just the work in Wilmington.

[67] "P. R. R. New Office Building," WBTJ, VI., no. 12, March 1905, p. 10.

[68] P. R. R., 1906, (60th), p. 30; 1907 (61st), p. 26.

APPENDIX I

Machinery List

No.	Machine Shop	Description of Motors
1.	Planer, 42 inch, Pond	20-H.P. 840 R. P. M.
2.	Planer, 36 inch, Putnam	
3.	Shaper, 9 inch, Bement and Dougherty	
4.	Drill Press, 36 inch, Chelingford	
5.	Lathe, 25 inch, Betts	
6.	Shaper, 12 inch	
7.	Rod Milling Machine, Sellers	
8.	Lathe, 37 inch, Putnam	
9.	Milling Machine	10-H.P. 840 R. P. M.
10.	Lathe, 20 inch, Bridgeport	
11.	Lathe, 24 inch, LeBlond	
12.	Universal Grinder, Landis	
13.	Lathe, 32 inch, Lodge & Shipley	
14.	Boring Mill, 42 inch, Bullard	30-H.P. 850 R. P. M.
15-16	Boring Mill, 37 inch, Bullard	
17.	Boring Mill, 60 inch, Sellers	
18.	Radial Drill, 22 inch, Sellers	
19.	Planer, 60 inch, Sellers	
20.	Planer, 38 inch, Niles	
21.	Planer, 42 inch, Sellers	
22.	Shaper, 12 inch, double head	
23-24	Lathe, 18 inch, Lodge & Shipley	
25.	Lathe, 30 inch, Sellers	
26.	Cold Metal Saw, Higley	
27.	Radial Drill, 30 inch, Betts	
28.	Slotting Machine, 12 inch, Bement & Dougherty	
29-30	Lathe, 30 inch, LeBlond	20-H.P. 840 R.P.M.
31.	Lathe, 25 inch, Betts	
32.	Lathe, 28 inch, Putnam	
33-34	Lathe, 20 inch, Fitchburg	
35.	Lathe, 18 inch, Lodge & Shipley	
36.	Lathe, 26 inch, Barr	
37.	Shaper, 12 inch, N.Y. Steam Engine Company	
38.	Duplex Milling Machine, Newton	
39.	Lathe, Warner and Swazey	
40.	Lathe, 20 inch, Fitchburg	
41-42	Turret Lathes, 16 inch	
43-44	Turret Lathes, 18 inch cabinet, American Tool Works	
45-46	Turret Lathes, 20 inch cabinet, American Tool Works	
47.	Grindstone, 7 feet	

48-49	Lathes, 18 inch, Hendey	15-H.P. 840 R.P.M.
50.	Drill Grinder, Sellers	
51.	Tool Grinder, Sellers	
52.	Cutter Grinder	
53.	Milling Machine, Brown & Sharpe	
54.	Universal Milling Machine	
55.	Drill Press	
56.	Shaper, 10 inch, Pratt & Whitney	
57-60	Lathes, 18 inch, Lodge & Shipley	
61.	Lathe, 17 inch, Fitchburg	
62.	Lathe, 18 inch, Fitchburg	
63.	Staybolt Machine	
64-66	Turret Lathes, 2 x 24 inch, Jones & Lamson	
67.	Turret Lathe, 20 inch, Bridgeport	
68-69	Lathes, doublehead axle, Brown & Zortman	20-H.P. 840 R.P.M.
70-71	Lathes, doublehead axle, Bement-Miles	
72-73	Lathes, doublehead axle, Niles	
74.	Drill Press, 36 inch, Shipley	
75.	Shaper, 12 inch, Fitchburg	
76.	Lathe, doublehead carwheel, Niles	28-H.P. 840 R.P.M.
77.	Lathe, doublehead carwheel, Bement-Miles	
78-79	Carwheel Draining Machine, doublehead	
80.	Boring Machine, 50 inch, Bement-Miles	
81.	Boring Machine, 50 inch, Sellers	

Tools Driven By Individual 2-Phase Induction Motors

100. 400-ton Wheel Press, Niles
101. Cold Metal Saw, Newton
102. Planer, 42 inch, Pond
103. Horizontal Cylinder Boring Machine, Barrett
104. Planer, 72 inch, Gray
105. Boring Machine, No. 2, Betts
106. Radial Drill, Putnam
107. 2-Spindle Rod Boring Machine, Niles
108. 300-ton Wheel Press, Niles
109. 150-ton Wheel Press, Niles
110. Boring and Turning Lathe, 37 inch

Tools Driven by Variable Speed Direct Current Motors

200.	Boring Mill, 100 inch, Betts	11-H.P. 510-1020 R.P.M. 3-H.P. 1000-2000 R.P.M.
201.	Slotter, 21 inch, Betts	11-H.P. 510-1020 R.P.M.
202.	Horizontal Milling Machine, Bement-Mills	20-H.P. 570-820 R.P.M.
203.	Wheel Lathe, 78 inch, Barr	16-H.P. 510-765 R.P.M.
204.	Wheel Lathe, 79 inch, Sellers	16-H.P. 510-765 R.P.M.

205.	Wheel Lathe, 90 inch, Pond	3-H.P. 1000-2000 R.P.M.
206.	Triple Geared Lathe, 48 inch	10-H.P. 630-945 R.P.M.
207.	Vertical Milling Machine, Hilles & Jones	10-H.P. 510-1020 R.P.M.

Boiler Shop

401.	Small Rolls, Hilles & Jones	
402.	Morgan Accumulator	
403.	Accumulator Pump	60-H.P.
404.	Hydraulic Riveter, Morgan	
405.	Flanging Furnace	
405.	Straightening Table	
407.	Large Rolls	20-H.P.
408.	Plate Planer, Hilles & Jones	7-1/2-H.P.
409.	Horizontal Punch, Hilles & Jones	7-1/2-H.P.
410.	Shears, Bisbee & Endicott	7-1/2-H.P.
411.	Punch, Hilles & Jones	7-1/2-H.P.
412.	Machine Punch	5-H.P.
413.	Punch, Pusey & Jones	5-H.P.
414.	Drill Press, Putnam	3-H.P.
415.	Universal Shear, Hilles & Jones	15-H.P.
416.	Punch, Hilles & Jones	10-H.P.
417.	Drill Press, Hilles & Jones	3-H.P.
418.	Spacing Table	
419-420	Clamping Machines	
421.	Flanging Furnace	
422.	Perforated Cast Iron Table	
423.	Annealing and Flanging Furnace, Ferguson	
424.	Laying Out Table	
425.	Emery Grinder	3-H.P.
426.	Brazing Furnace	
427.	Emery Grinder	3-H.P.
428.	Flue Expander and Ferguson Furnace	
429.	Flue Testing Machine	
430.	Cutting-Off Machine	3-H.P.
43].	Flue Welder and Ferguson Furnace	
432.	Cutting-Off Machine	

Blacksmith Shop

Tools Group Driven By Constant Speed 2-Phase Induction Motors

Combined Shear and Punch 3-1/2 inch single head bolt cutter 1-1/2 inch single head bolt cutter 2 inch triple head bolt cutter Small Shear (cuts 1-1/4 inch diameter) 32 inch Drill Press Three 36 inch Drill Presses	20-H.P. 840 R.P.M.
1-1/2 inch bold heading machine 1-1/2 inch upsetting and forging machine 2-1/2 inch bolt heading machine	20-H.P. 840 R.P.M.

60,000 pound spring testing machine	10-H.P. 840 R.P.M.
Nibbling, Rolling and Shearing Machine	

Tools Driven By Individual 2-Phase Induction Motors

63 inch Boston Cupola Forge Blower	15-H.P. 1120 R.P.M.
No. 10 Sturtevant Fan	15-H.P. 1120 R.P.M.
90 inch double exhaust fan	20-H.P. 840 R.P.M.
Cambering Machine for Springs	3-H.P.
Cambering Machine for Springs	3-H.P.
Helve Hammer	3-H.P.

Planing Mill

Flooring Machine	30-H.P. 850 R.P.M.
Vertical Hollow Chisel Mortiser 5-Spindle Vertical Boring Machine	10-H.P. 840 R.P.M.
Vertical Cut-Off Saw (38 inch diameter saw)	10-H.P. 1120 R.P.M.
End Tenoning Machine Large Vertical Cut-Off Saw	15-H.P. 1120 R.P.M.
3-Spindle Vertical Borer Gainer Horizontal Borer 3-Spindle Borer Vertical Mortiser	10-H.P. 1120 R.P.M.
3-Spindle Vertical Borer Gainer (50 foot table) 2-Spindle Horizontal Borer	10-H.P. 1120 R.P.M.
Band Saw	3-H.P. 112- R.P.M.
Tenoning Machine	5-H.P. 1120 R.P.M.
Jointer (20 inch knife)	5-H.P. 1120 R.P.M.
Shaper	3-H.P. 1120 R.P.M.
24 inch x 24 inch x 37 foot bed planer	10-H.P. 1120 R.P.M.
Rip Saw (self feeding) Universal Wood Worker Jointer	15-H.P. 1120 R.P.M.
40 inch Cross Cut Saw	10-H.P. 1120 R.P.M.
19 Inch Heavy Timber Planer	40-H.P. 830 R.P.M.
Self-feed Rip Saw	15-H.P. 1120 R.P.M.
Surfacer (double cycle, endless bed, 30 inches wide)	15-H.P. 1120 R.P.M.

Cabinet Shop

Tools Group Drive By Constant Speed 2-Phase Induction Motors

Band Saw Sharpener Grindstone Knife Grinder Cutter Grinder	15-H.P. 1120 R.P.M.

Emery Wheel Turning Lathe Two Tenoning Machines Horizontal Mortiser	15-H.P. 1120 R.P.M.
Combination Rip and Crosscut Saw No. 2 Band Saw 20 inch Circular Saw 3-Spindle Borer	10-H.P. 1120 R.P.M.
30 inch double cylinder roll feed surfacer Rip Saw Jointer (16 inch knife) No. 4-1/2 surface planer (24 inch knife) Band Saw Jointer (12 inch knife)	30-H.P. 840 R.P.M.
Double Blind Slat Planer Moulding Machines Sandpaper Machine, cylinder 24 inches long	20-H.P. 1120 R.P.M.
Panel Smoothing Machine Blind Slat Mortiser Small Moulding and Shaping Machine No. 1. Vertical Mortiser	20-H.P. 1120 R.P.M.
Small Moulding Machine	3-H.P.
Scroll Saw	3-H.P.
Combination Rip and Crosscut Saw	15-H.P. 1120 R.P.M.

WILMINGTON HEAVY REPAIR SHOPS AND WORK PERFORMED

(1) MOTOR SHOP	Rebuild and repair GG1 traction motors, which includes either partial or complete rewinding of stators and armatures, undercutting, balancing, seasoning and baking.
(2) LOCOMOTIVE SHOP	Running repairs, monthly inspection of 108 GG1 locomotives and 59 diesels, including both mechanical and electrical work on the interior and exterior of cabs; underframe, wheels, application and removal of traction motors, plus 42 Diesels from Baltimore for periodic inspections.
(3) MACHINE SHOP	Repairs to GG1 driving wheels and axles, journal boxes, quills, bearings and remove and apply tires. Machining of brake and spring rigging parts and quill bearings. Maintain industrial trucks. Joint responsibility with Locomotive Shop in maintenance and repairs to locomotives. Also responsible for maintenance and operation of shop machinery and heating system.
(4) WHEEL AND BLACKSMITH SHOP	Wheel repairs for passenger and freight cars and diesel locomotives, including mounting, dismounting, and truing of wheels, for Wilmington and points on the Eastern Region. Magnaflux and Ultrasonic testing of axles. Repairing of journal boxes, spring and brake rigging for cars in both passenger and freight service; locomotive parts. Blacksmith shop handles miscellaneous repairs to locomotive and passenger car parts.
(5) ELECTRIC SHOP	Repair and rebuild relays and switch groups, traction motors for M.U. cars including partial or complete rewind of armatures and stators, undercutting, seasoning, and baking of armatures.
(6) CAR ELECTRIC SHOP	Running repairs and monthly inspection of Metroliner cars. Repair and rebuilding of trucks for passenger car equipment. Remove and replace trucks. Repairs to passenger car bodies including the preparation for painting. Repair, manufacture or clean seats and backs for cars, window curtians for passenger equipment.

(7) PAINT SHOP — Clean, prepare and paint exterior and interior of passenger equipment, including lettering and stenciling.

WILMINGTON HEAVY REPAIR SHOPS SERVICES PERFORMED

1. Maintain 108 GG1 Electric locomotives and selected heavy repairs to E-44 locomotives.

2. Manufacture, repair and rehabilitate components for GG1's, including 530 traction motors and 72 compressors annually.

3. Dispatch 35 locomotive units daily and perform running repairs, yard and emergency repairs from Thurlow to Perryville and Delaware Road to Delmar.

4. Refurbish M.U. cars, repair wreck damaged M.U. cars and selected modifications to the Silverlines.

5. Manufacture, repair, and rehabilitate components for M.U. cars, including 660 traction motors, 225 compressors, and 730 wheel drive units.

6. Maintain 59 diesel units plus all heavy repair work on 36 more. 35 are Baldwins, 35 are Alcos, and 24 are EMDs.

7. Turn or remount 450 pair of passenger car wheels annually for Sunnyside Yard, New York.

8. Maintain and repair shop machinery, shop utilities, various lift bridges, wreck derrick, and stationary equipment on Chesapeake division.

9. Maintain and repair 60 Metroliners and repair selected components, including 54 air compressors annually.

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Middleton, William D., When the Steam Railroads Electrified. Milwaukee: Kalmbach Publishing Company, 1974.

Good book on electrified railroads, excellent illustrations. Contains a chapter on the Pennsylvania's electrification of the 1930s.

Plowden, David, Bridges: The Spans of North America. New York: The Viking Press, 1974.

Excellent summary of America's bridges. Again, well illustrated.

Schotter, H. W., The Growth and Development of the Pennsylvania Railroad Company. Philadelphia: Allen, Lane & Scott, 1927.

Good company history.

Stover, John F., American Railroads, Chicago: University of Chicago Press, 1961.

The standard short history of American railroads.

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The Mutual Magazine, 31, no. 10, April 1946.

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Wilmington Board of Trade Journal

This journal has numerous articles during the length of its run which contain details of the work and its progress.

Wilmington.

More or less the successor publication to the WBTJ, this magazine was published by the Wilmington Chamber of Commerce. Has a couple of articles on later alterations to the repair shops.

The Railway Age, (Chicago).

This weekly magazine was the single most helpful source for this report. There were three invaluable articles:

8 April 1904; volume 37, pp. 752-764, on the shops.
31 March 1905; volume 39, pp. 532-535, and
3 November 1905; volume 40, pp. 561-566. Both of these are general summaries of the work.

"Waterproofing Brick Arches," The Engineering Record, 52, no. 22. 25 November 1905, p. 603.

Article on the brick arches of the viaduct.

Annual Reports

Pennsylvania Railroad Company.

56th, 1902
57th, 1903
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59th, 1905
60th, 1906
61st, 1907

Philadelphia, Wilmington and Baltimore Railroad Company

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5th, 1907
6th, 1908

Maps

Franklin Survey Company, Property Atlas of the City of Wilmington. Philadelphia, 1936. Plate 3.

Sanborn Map Company, Insurance Maps of Wilmington, Delaware, New York, 1927, with later revisions. Plate 29.

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Oral Interviews

Discussion and visit to the shops with F. T. Rossbach and R. McCurdy
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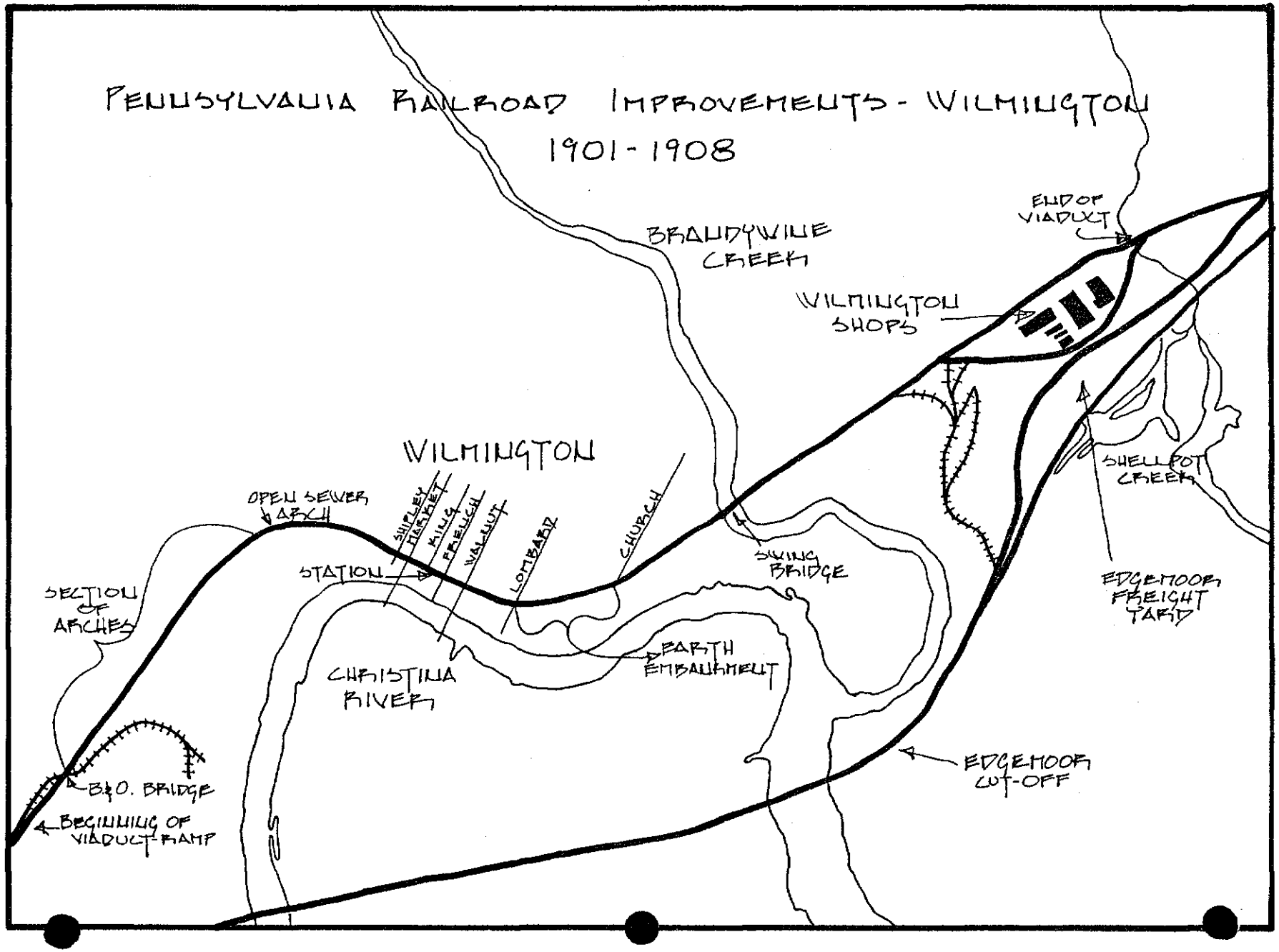

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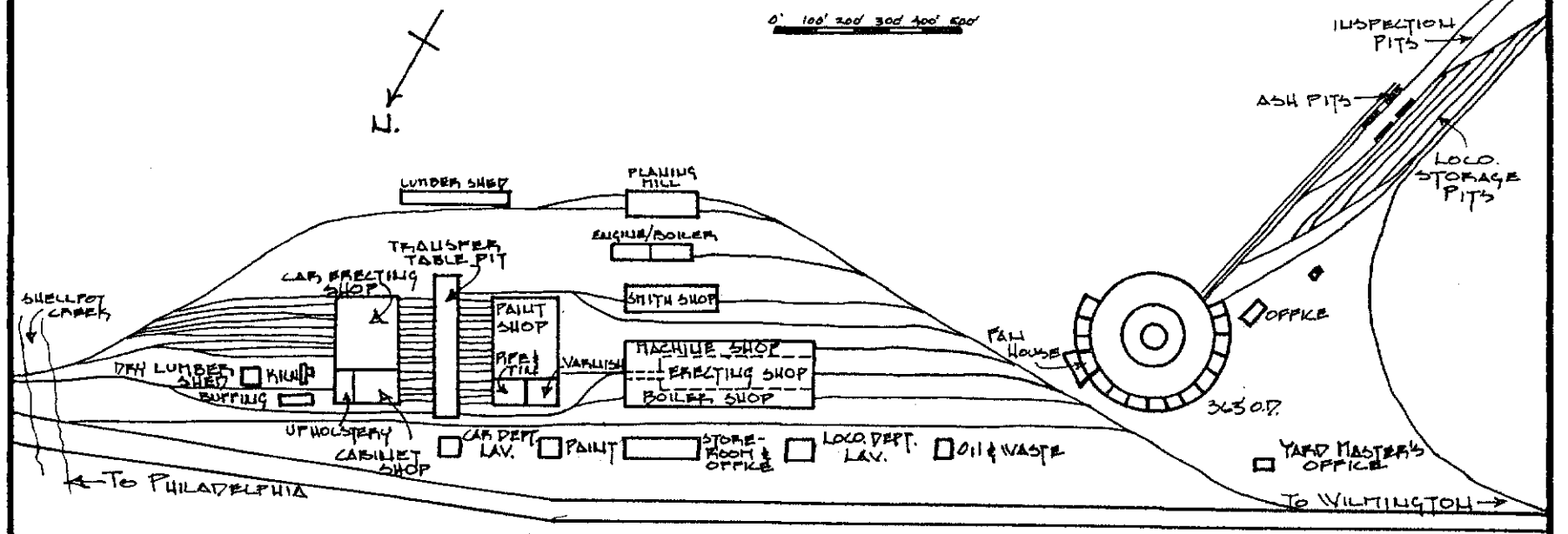
PENNSYLVANIA RAILROAD - WILMINGTON SHOPS 1903-1905



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WILMINGTON HEAVY REPAIR SHOPS